INTRACRANIAL NEURECTOMY OF THE FIFTH NERVE.

By FRANK HARTLEY, M.D.,

OF NEW YORK.

SURGEON TO THE NEW YORK AND TO THE CANCER HOSPITALS; ASSISTANT SURGEON TO ROOSEVELT HOSPITAL.

IN an article published in the *Archiv für klinische Chirurgie*, Band XLIV, viertes Heft, Prof. Fedor Krause claims to be the originator of a method for intracranial neurectomy of the fifth nerve, which I find upon reading is in every particular similar to a method devised by me. My operation was devised and practiced upon the cadaver for one and a half years before its performance upon the living subject. It was performed six and a half months before Prof. Krause's operation, and was shown at the New York Surgical Society one and a half months before the performance of his operation. My case was published in the *New York Medical Journal* of March 1, 1892. Prof. Krause read his paper at the meeting of the Deutsche Gesellschaft für Chirurgie, June 10, 1892, and published it in *Archiv. für klinische Chirurgie*, October 11, 1892.

As there seems to be some misunderstanding in the exact detail of the method, I have deemed it not out of place to give a resumé of the cases so far performed according to this method, and an account of the operation itself.

The method is as follows:[1]

An omega-shaped incision was made, having its base at the zygoma and measuring a distance marked by a line drawn from the external angular process of the frontal bone to the tragus of the ear.

The curved and rounded portion of this incision reached as high as the supratemporal ridge, the diameter of said circle being three inches. The skin and deeper tissues were cut in the shape of the Greek capital letter omega. This incision was carried down to the periosteum of the skull in all portions of the incision, except in the straight part at the base; the tissues were then retracted and the periosteum divided upon the bone in the same direction and as far as the straight part at the base.

---

[1] Copied from the New York Medical Journal, March 19, 1892.

With a chisel a groove was cut in the bone corresponding to the divided periosteum. This groove went to the vitreous plate, except at the upper angle over the rounded portion, where it included the vitreous plate.

A periosteum elevator was here inserted and used as a lever to snap the bone on a line between the ends of the circular portion of the incision. In this way the breakage occurs along the lower portion of the wound, and a flap, consisting of skin, muscle, periosteum and bone, is thrown down, exposing the dura mater over a circular area of three inches in diameter. The middle meningeal artery was tied, the dura mater separated from the bone, and the floor of the middle fossa of the skull was exposed. Broad retractors were used to raise the dura mater with the brain, and to expose the foramen rotundum and the foramen ovale. The hæmorrhage was stopped by sponge pressure. The exposure of the first, second and third divisions of the fifth nerve, together with the carotid artery and cavernous sinus, was exceedingly good.

The second and third divisions were isolated at the foramen rotundum and the foramen ovale, and, by slight pressure upon the dura mater, it could be stripped from the nerves to beyond the Gasserian ganglion. These were divided with a tenotome at the foramen rotundum and the foramen ovale, and that part between these and a point beyond the Gasserian ganglion was excised. As this amount of nerve is not very great, the ends of the nerves were pushed through the two foramina so as, if possible, to interfere with any reunion. In the retraction of the dura mater, owing to imperfect instruments, the third, fourth and sixth nerves were somewhat injured. As no bleeding was present, the brain was allowed to fill the fossa. The flap—consisting of bone, periosteum, muscle and skin—was replaced. The irregular edge of the vitreous plate which remained attached to the bone not involved in the flap acted as a shelf on which the flap rested, and prevented its falling in upon the dura mater. The periosteum was stitched, the muscle sutured in place, and the skin sewn with silk. One drainage tube was inserted at the lower angle; an antiseptic dressing was applied. Time of operation, one hour and forty minutes; the patient was carried to the ward in good condition. The disadvantage was the inability to resect as long a piece as could be done in some of the other methods.

The operation was performed on August 8, 1891, in the manner described above. The history of the case was as follows:

J. D., aged forty-six years, married, England, salesman, admitted to Roosevelt Hospital on August 8, 1891. The patient's father died of pleurisy; in other respects his family history is negative.

Personal History.—Patient denies rheumatism and syphilis. He has had malarial disease, but in other respects has been perfectly healthy.

In December, 1882, he was seized with a sharp neuralgic pain, at first referred to a spot about two inches to the left of the symphysis menti. This pain radiated over the whole left side of the face and head, involving the temporal region as far as the temporal ridge, and the left side of the tongue and mouth over the upper and lower jaws. The left orbit was involved in this attack.

This attack lasted eighteen hours, and, after an interval of four days, during which time momentary attacks of pain were present in the same region, it reappeared. The second attack was more severe, and lasted two or three days. For the next two years he had constant pain over this region, and was treated medicinally with aconitine and morphine.

In September, 1884, the infra-orbital nerve, with Meckel's ganglion, was removed.

From the scars left, one would judge that either Wagner's or Chavasse's operation was performed at this time.

For four or five weeks he had partial relief. The constant pain disappeared, but the spasmodic twitchings continued. It soon reappeared, however, and the patient was again treated with aconitine and morphine.

He had at this time thirty-one teeth drawn, thinking that the origin of the pain was located in them.

After eighteen months (1886), section of the inferior dental nerve was made by the same surgeon. The scars would lead one to think that Velpeau's operation was performed at this time.

On recovering from the ether he had an attack lasting seventeen days. From that time to the present he has had no change in his condition. The pain has been constant, except for an occasional period of one or two days. The contractions in the muscles of the face amount to forty in about thirty minutes.

Owing to the previous operations and the involvement of the lingual and auriculo-temporal nerves, I decided to attack the nerve at a point where I could divide the second and third divisions of the fifth nerve completely by one operation. The operation intended was to attack the nerve on the inner surface of the skull outside the dura mater, to isolate the second and third branches completely, to divide and resect as long a portion as possible. The advantages thought to exist in this method over Pancoast's, or its modification by Krönlein, Credé and Salzer, or Lücke's operation, were the easy access to the nerve, the comparatively large field for work, the rapidity with which the operation could be done, and the small amount of hæmorrhage.

For the week following the operation the patient did well, and was free from pain.

August 16.—On changing the dressing, ptosis of the left upper lid appeared, together with double vision and inability to move the eye. The patient was entirely free from pain, and continued to do well for one week.

August 23.—To-day a slight dermatitis appeared over the area of operation, which is treated with ichthyol (10 per cent.) and bichloride irrigation.

On August 24 Dr. W. Vought examined the patient for me, and reported as follows: "The area of anæsthesia may be seen upon the shaded portion of the drawing. The other areas were the left side of the mucous membrane of the mouth over the upper and lower jaws, of the soft palate, of the anterior two-thirds of the left side of the tongue, of the left conjunctiva and cornea, and of the left nostril. Muscular paralysis, complete, of the left buccinator, the pterygoids, and the left occipito-frontalis (frontal portion); almost complete, of all the external muscles of the eye. Ptosis: pupil normal. Nerves divided: the second and third divisions of the fifth nerve, the branch of the seventh to the occipito-frontalis; injured, the third, fourth and sixth nerves. The ophthalmoplegia externa I should give a fair prognosis for spontaneous recovery, as you will see by examining the patient that *slight* movement of all the eye muscles is present, which leads me to think the nerves have not been divided, but merely severely injured. The ptosis could be corrected at any time."

August 30.—Patient is to-day discharged cured, and returned to the Vanderbilt Clinic, Nervous Department.

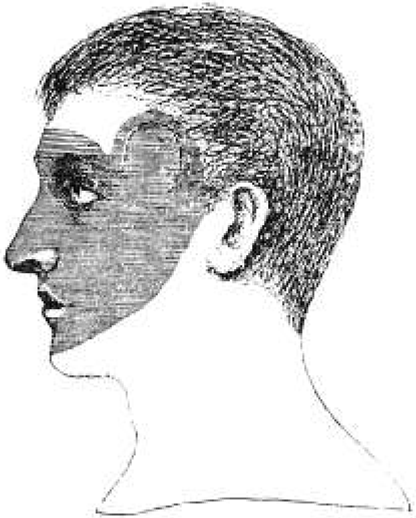

Fig. 1.—Showing area of superficial anæsthesia after intracranial neurectomy.

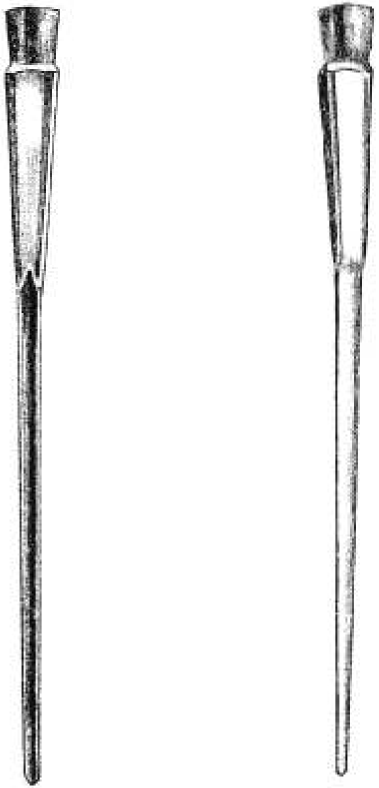

Fig. 2.—Chisels used for cutting cranial wall.

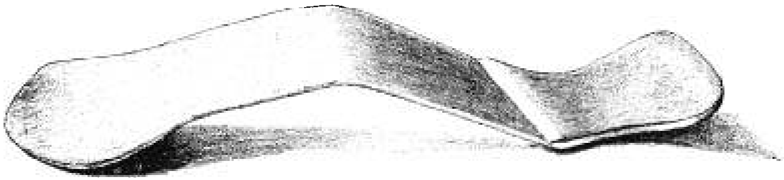

Fig. 3.—Retractor for holding brain out of the operative field.

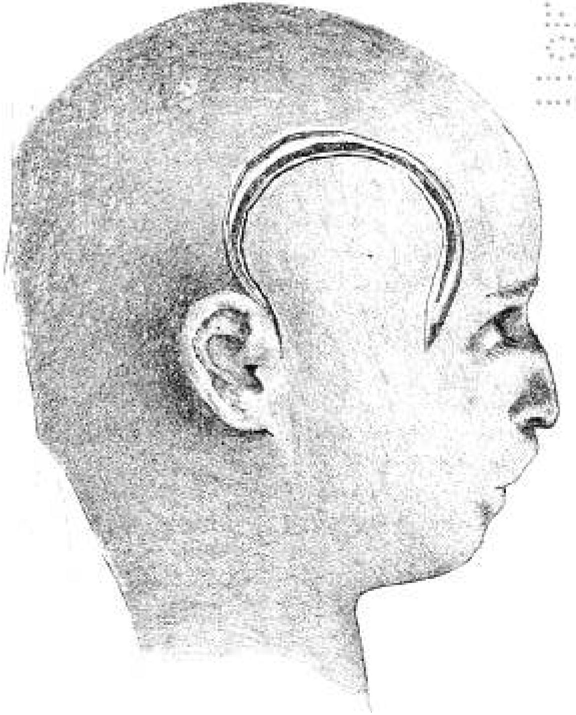

Fig. 4.—Showing primary incision through soft parts.

September 30.—Patient has recovered from his paresis in the third nerve; the double vision, ptosis and inability to use the third nerve have entirely disappeared. The paralysis of the pterygoids, temporal and masseter muscles, produced by the division of the motor portion of the fifth, seems to have incommoded him to a very slight extent. The false teeth worn in the lower jaw before the operation fit quite accurately their opponents in the upper. Protraction and retraction of the lower jaw seem to be diminished, but elevation and depression of the lower jaw seem good. As the patient has chewed since 1882 all his food on the side opposite to the present paralysis, he has not been distressed by the division of the motor portion of the fifth.

January 1, 1893.—The patient informs me that he is at present entirely free from pain, and has gained in weight sixteen pounds.

The patient was presented to the New York Surgical Society on January 13, 1892. The second operation was performed by Prof. Fedor Krause February 23, 1892. An account of this operation was published in the *Archiv. für klinische Chirurgie*, October 11, 1892, and this paper was read at the Twenty-first Congress der Deutschen Gesellschaft für Chirurgie, June 10, 1892. The history of the case is as follows:

Female, aged forty-seven years. Prof. Volkmann just before his death had performed neurectomy of the second division of the fifth upon this patient, taking out the nerve from near the foramen rotundum to its terminal branches.

Almost immediately after the operation a recurrence of pain took place. The patient was again operated upon by a method combining portions of Krönlein's and Salzer's methods, in which the divided end was found in the spheno-maxillary fossa, and torn out from the foramen rotundum. One and a half centimetres of the nerve were thus obtained. In eight days the patient's wound was healed. A few months later a second recurrence of pain took place.

On February 23, 1892, an operation was performed which in many of its points resembles my own. The incision, the cutting of the bone, its elevation, and the raising of the dura mater are all similar. The amount of hæmorrhage obtained in this case was far greater than seen in any of the cases so far performed. On account of this hæmorrhage, which occurred during the separation of the dura mater from the bone, the cavity was packed with iodoform gauze and a dressing applied. Five days later the patient was again chloroformed, and the dressing was removed, together with the iodoform gauze packing. The nerve was found, and one-half centimeter of the second division of the fifth nerve was excised. The iodoform gauze packing was replaced between the dura mater and the bone and a dressing applied. A few days later all packing was removed, the bone, muscle and skin flap was replaced and each tissue was accurately coapted. The union was undisturbed.

On September 15, 1892, the patient was reported as well, with no recurrence.

The third operation was performed by Dr. Chas. McBurney.

Woman, aged sixty-four years, native of Germany, was admitted to Roosevelt Hospital on July 8, 1892. Family history was negative. Personal history: For fourteen years the patient has suffered from neuralgia of the face. The pain has been paroxysmal in character. During the last five years the pain has increased in intensity, and in the frequency of the paroxysms. Ptosis of the left eye and lachrymation are present and are increased during the paroxysms. The area affected by the neuralgia seems to be the three branches of the fifth nerve. The urine is acid; specific gravity is 1012; no albumen; no sugar; clear. Microscopic examination is negative.

July 27, 1892, an omega excision, extending from below the zygoma just behind the frontal process and carried as high as the temporal ridge, was finished in front of the antihelix. The incision extended to the bone. The bone was chiseled in the incision and the flap, consisting of the superjacent tissue and bone, was raised with an elevator. This flap was turned down over the zygoma. The dura mater was separated from the bone. The brain was raised with a retractor, and the fifth nerve was exposed.

The second and third divisions were cut, and the ends were separated as much as possible. Bleeding had not been excessive. This was readily stopped by sponge pressure. The flap was replaced. The periosteum and superjacent tissue was united with catgut. The skin was sutured with silk. In the anterior angle of the wound a short drainage tube was inserted. Antiseptic dressing was then applied.

The reaction from operation was good. In the first twenty-four hours the temperature reached 101°. It reached the normal on the next day.

Ptosis of the left eyelid was present after operation, and continued for one week. The wound healed by primary union. The patient was discharged from the hospital on August 14 with no return of the pain.

The fourth case was operated upon by Dr. John B. Roberts, of Philadelphia, on November 5, 1892, and was published in pamphlet form as follows:

"The patient is a man seventy-six years of age, on whom I operated about two years ago for frightful neuralgia, which affected the first and second branches of the fifth cranial nerve. He had been operated on previously without success. I removed the supra-orbital and infra-orbital nerves at their anterior foramina, chiseling away the lower part of the orbit in order to tear off the latter nerve as far back as possible. He had a period of comfort for perhaps a year, when the disease returned. He was then operated on, I think, by Dr. John B. Deaver. I do not know what Dr. Deaver did, but I believe that he cut out the cicatrix. The man came to see me again a year ago, and I decided to ligate the primitive carotid, which has been recommended in some of these cases, and which I had found satisfactory in a case operated on six months previously. I operated last November, tying the primitive carotid with catgut. He was discharged at the end of three weeks, suffering no pain.

He again began to suffer, and has appeared at my office two or three times in the last three or four months. His pain was so great that I decided to attempt the removal of the Gasserian ganglion. I had long made up my mind that the route advised by Rose, of England, of cutting away the coronary process of the lower jaw and the zygoma, and trephining from below, was an operation of great severity; and although he has reported several cases of cure, I had about made up my mind that I would not try it. In March of this year I saw the description of the operation proposed by Hartley, of New York, which is somewhat similar to that of Horsley. An opening is made by Horsley in the temporal region, the dura mater opened, and by getting under the temporal lobe the fifth nerve is cut off at the pons, and the ganglion also removed. The case on which this operation was done died. When I saw Hartley's operation described, it seemed to me that it presented the better method, and

I determined that I would adopt it in a case where such operation was indicated.

Four days ago I made an omega-shaped incision, beginning at the external angular process of the left side, ascending to the temporal ridge, and coming down at the tragus. With a sharp chisel I cut through bone in the same line; above, going down to the dura mater, but below through to the diploë only. With a lever the bone, muscle and integument were turned down over the zygoma as an osteo-cutaneous flap. This exposed the dura mater and the middle meningeal artery. The trunk of the artery was not torn, because it ran in a groove and not in a foramen at the angle of the parietal bone. A small opening in an upper branch was bleeding, and was secured by two sutures passed above and below the opening. The dura mater was next separated from the base of the skull and the foramen rotundum exposed. I was surprised at the ease with which I could press the brain over to the right to make room for my manipulations. As I pressed upon the brain the man's left hand—that is, on the same side as the operation—went into a state of tonic contraction or spasm, which disappeared as soon as the extreme pressure was stopped. With a tenotome I cut off the second division of the fifth nerve. which was the one that gave pain, close to the round foramen, and endeavored to follow it back to the ganglion. I was unwise in using a blunt pointed tenotome, dissecting backward along the nerve, for before I got through the dura I cut or tore the nerve off close to its attachment to the ganglion. This made me lose my landmarks, and I could no longer trace my way back by holding on to the nerve with forceps. I then cut off the third division at the oval foramen, and again made the attempt to dissect up to the ganglion, but practically the same thing happened. During this time there was a good deal of bleeding, probably from the petrosal sinus, but by changing the position of the patient's head the blood did not obscure the field, and with the electric light and head mirror I had a good view. After spending considerable time I concluded, after consultation with my colleagues, that I had probably done enough, without uncovering and removing the Gasserian ganglion. I had excised the painful nerve (the second division) from close in front of the ganglion to the round foramen, and had pushed the distal end of the nerve forward into the canal. I had also excised the third division from the Gasserian ganglion to the oval foramen and pushed the distal stump into its canal in the same manner. The flaccidity of the dura rendered it a little difficult to cut through the layer covering the ganglion with accuracy. The use of a uterine tenaculum to make the dura tense would probably have helped me.

I allowed the brain to come back into place, shut down the lid of bone, and sutured the skin, using no drainage. The eyelids of the left eye had been sewed together before the operation, lest corneitis might develop after removal of the ganglion.

The patient has done so extraordinarily well that I can hardly believe it myself. He has not had a bad symptom; there has been no paralysis, no aphasia, and he has needed no anodyne. This is the fourth day. The pulse is 72; respiration, 17, and temperature 98.4°. There has been no neuralgic pain. He has the same "queer" sensation in the infra-orbital region which he had after ligation of the carotid artery, and which soon disappeared. On the second day I found him slightly propped up in bed reading the paper. He catheterizes himself three or four times a day, being the subject of old bladder disease, and is doing perfectly well. The portions of the nerves removed are shown in the bottle which I have passed around.

NOTE.—It is now eighteen days since the operation, and the wound is entirely healed by first intention. The man is well, except that he complains of headache. This is probably due to the aseptic cerebral inflammation at the seat of traumatism. He is up, goes out, and has normal respiration, pulse and temperature. He reads, talks and seems the same as before operation, except that he is relieved of the torturing neuralgic pain, and has the dull headache. He complains of an "ugly" feeling at times in the cheek. It is not at all the pain he had previously. After this report was written it was noticed that he could not recall the names of the city streets and of the physicians. This was probably an aphasic symptom, and it is now improving, being scarcely noticeable.

The fifth operation was performed by Dr. Chas. McBurney:

Male, aged fifty-one, native of France, was admitted to Roosevelt Hospital January 9, 1891, suffering from an intense supra-orbital neuralgia upon the left side. The duration of this neuralgia was eight years, During the last few months the pain has been shooting in character, and the paroxysms last one or two minutes. The pain shoots over the forehead and down the side of the nose and upper lip, Talking now brings on the pain, although formerly this was not the case.

Physical examination of the patient is negative. The urine is acid, clear, and the specific gravity is 1030. No sugar or albumen is present. Microscopical examination is negative. Operation. Ether. Incision just above supra-orbital ridge, transverse one and a half inches in length. The nerve was found and drawn out from under the orbital margin; one and a half inches of the nerve was excised. Dressing.

January 10. Several attacks of pain, but the paroxysms were not so frequent as before. Temperature normal.

January 11. Patient had four attacks this morning.

January 12. Several long and severe attacks, lasting five to ten minutes.

January 13, 14, 15, 16. No pain in the supra-orbital region, but it still continues in the nose, cheek and lip.

January 19. Infra-orbital nerve excised by an incision parallel to the infra-orbital margin, and finding the nerve lifting the eyeball and cutting it as high as possible. Drainage tube and dressing.

January 20. No pain.

January 24. Wound healed and patient discharged. Readmitted to hospital December 9, 1892.

Patient complains of intense pain over the left side of the face, through the distribution of the fifth nerve. It involves the tongue (left half), the cheek over the infra-orbital and supra-orbital regions, extending over the scalp as far as the posterior border of the ear and to the median line.

The pain is now continuous, without paroxysms of increased severity.

Operation.—December 9, 1892. From the external angular process a curved incision was made running as high as the temporal ridge, and ending one-half inch in front of the meatus of the ear. This incision was carried to the bone, and the groove in the bone was cut along the line of incision. A very small trephine (three-eighths of an inch) was used at the highest point of the upper border, in order to insert the elevator beneath the bone. The bone is elevated and snapped at the lower part. The middle meningeal artery is ligated. Dura mater was lifted together with the brain and held away by retractors. The second and third divisions of the fifth nerve were caught, and a small piece removed. The flap was replaced. Antiseptic dressing applied.

December 10. No pain; temperature, 99.8°.

December 12. No pain; temperature, 103°. Dressing is removed; wound is aseptic; slight ptosis and internal strabismus. Dressing reapplied.

December 17. Sutures removed. Primary union.

December 21. Ptosis has almost completely disappeared. Patient discharged from the hospital.

These cases comprise all of those which I have been able to find in literature which have been performed in this manner. It is interesting to note that though the method has been used by four different operators, in all cases the symptoms have been relieved, the healing of the wound has been by immediate union in four cases, and in one case without suppuration, though delayed for several days. In no case has there been a fatal issue, nor has there been any evidence of shock, concussion nor lasting contusion of the brain from the manipulations.

Since my first operation I have been interested particularly in the hæmorrhage which occurs, or may occur, during the operation, in the ability to remove the nerve to and beyond the Gasserian ganglion, in the complete union of the osteo-periosteal flap, as well as in an easy means of dividing the bone.

During the incision through the skin and to the bone the hæmorrhage is easily checked by forceps. In chiseling the groove in the bone, the hæmorrhage encountered is easily checked and removed by sponges, so that it does not in any way interfere with the operator. As the hæmorrhage here is derived alone from the diploë, it is never severe, nor difficult to check with pressure.

The middle meningeal artery, unless it be enclosed in the groove in the parietal bone, is not injured in elevating the flap, and should it be injured it is in full view, and its ligature is an easy matter. The hæmorrhage in separating the dura mater from the bones, provided it be done with the finger and carefully, is never of moment. The middle meningeal artery is carried in the dura mater away from the bone, and will not in gentle manipulations be injured. One can separate the dura with safety and ease until the foramen ovale and spinosum are seen. It may be here ligated or left without a ligature, provided the dura separates easily, and to such an extent as to allow one to follow the nerve. There is no difficulty in stopping this hæmorrhage by pressure, for I have only in the last week had a case in which hæmorrhage from the cavernous sinus was readily controlled by pressure during an operation for a perforating wound of the base of the brain and hæmorrhage from cavernous sinus. When one approaches the puncture of the second and third divisions of the fifth nerve on the outer border of the cavernous sinus care must be exercised in separating the dura from the wall of the sinus.

This is especially true when the nerves have been divided at the foramen rotundum and ovale, and the dissection is being carried up through the canal of Meckel over the carotid artery. In all cases it is necessary to notice whether a lesser meningeal branch is ascending through the foramen ovale before dividing the nerve here. Sponge pressure is quite sufficient to stop hæmorrhage from this point.

The trigeminus nerve leaves the pons on the ventral portion of the crura cerebelli ad pontem by two roots, which are separated by a small interval, the Lingula Wristergii. The small and inferior root is motor. The large and posterior root is sensory. The nerve passes out external to the sixth or abducens nerve between two layers of the dura mater into a cavity called the Cavum Meckelii. This cavity or canal in the dura mater passes from the impressio trigemini of the temporal bone external to the cavernous sinus to the angle of the supra-orbital foramen, the foramen rotundum and foramen ovale. The structure of the sensory portion of the nerve changes at the superior border of the petrous portion of the temporal bone, in that the parallel bundles of the nerve separate and again uniting form the triangular plexus in which many ganglion cells are found. The nerve then enters the Gasserian ganglion, which extends from the posterior apex of the clinoid process posteriorly and laterally to the external border of the internal opening of the carotid canal. It is flattened from above downward, and is half-moon-shaped, with its convex border placed anteriorly. The superior portion is closely attached to the internal layer of the dura mater, while its superior surface is loosely attached to the

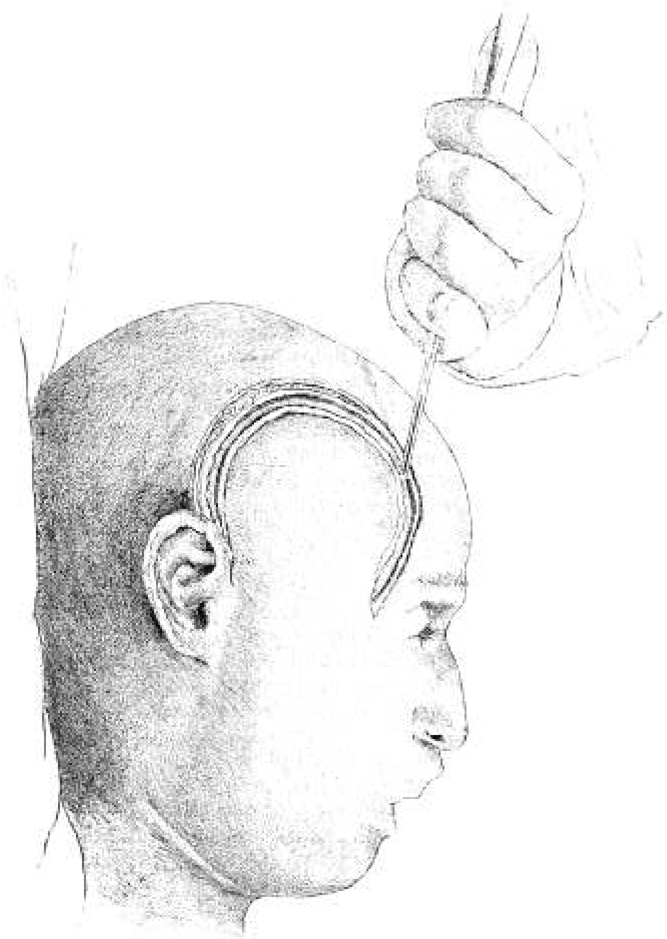

FIG. 5.—Showing manner of holding the chisel in cutting the groove through the bone.

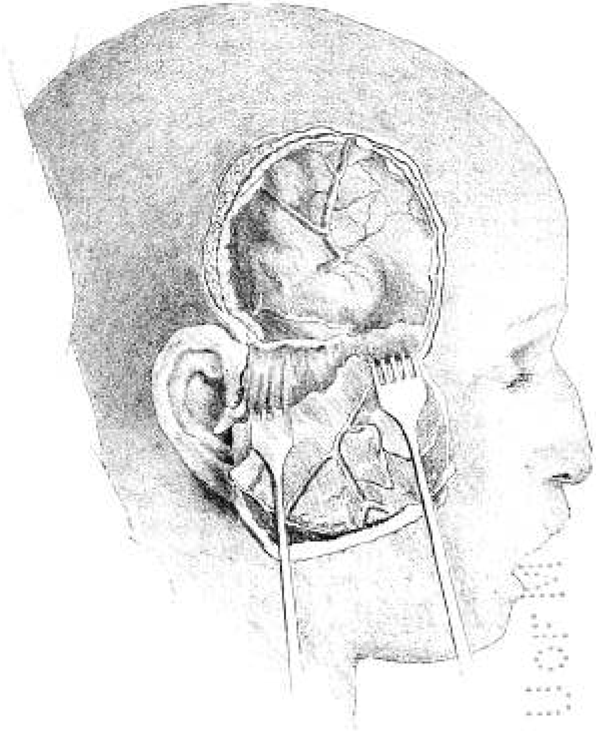

FIG. 6.—Flap elevated and turned down, exposing dura mater and middle meningeal artery.

external layer of the dura mater. From its anterior border it gives off the first, second and third divisions of the nerve. The ganglion lies between the external and internal layers of the dura mater, and is very loosely attached to the external layer, while its attachment to the internal layer is close. The cavernous sinus is situated internally to this, between two layers of the external division of the dura mater. If one keeps in mind the anatomy of this region, not only can the second and third divisions be completely removed, but the ganglion as well. The ganglion is accessible as far as the superior border of the petrous portion of the temporal bone, if one will divide the second and third divisions below at their foramina and fastening them with a forceps or hook, divide the dura mater covering the nerve so as to lift the roof of the Cavum Meckelii and separate the ganglion from this wall. This division of the dura mater is made at the outer border of the cavernous sinus and the carotid artery. The traction upon the nerves allows of an exposure of the ganglion, which can now be torn out, divided with a tenotome, or removed with a very fine Volkman spoon. The ganglion lies over the carotid artery, and is not so difficult to remove as one would imagine.

I have made use of various means for dividing the bone, including electrical saws, gouges and chisels, but have been unable to find any instrument which could accomplish the division of the bone in a more rapid manner than a chisel used by cabinet makers, and modified by Dr. C. F. Parker and myself. This chisel is used in two sizes, one fitting exactly into the groove of the other one. (See Fig. 2.)

It consists essentially in a groove made upon a blade which is triangular upon cross section. The blade increases in size as it approaches the handle. At the cutting edge the triangle is gradually lost, so that it presents a deep groove only at its end. The deeply-grooved edge when the chisel is properly sharpened and held at an angle of forty-five degrees to the skull, will always cut in a line parallel to the skull. The elevation or depression of the handle will cut away a thicker or thinner piece as one wishes. When the chisel is properly held, the bone removed is always upon the same level. I have repeatedly tried to injure the dura mater with the chisel held at forty-five degrees, and have been unable to do it, as the shoulder formed by the triangular portion in sharpening it protects the dura.

With the larger chisel the groove is cut nearly to the vitreous plates in one continuous motion. The smaller chisel is then used and the remainder of the bone is cut. This is accomplished by the smaller chisel without cutting any bone already cut. This facilitates the cutting of the bone. The second chisel is made to occupy the groove of the larger one, and will not cut bone already cut by the larger one. Two specially made retractors may be used to advantage. The more important one is broad and flat, and made so as to fit the inequalities of the floor of the middle fossa of the skull near the cavernous sinus at its extremity, while it becomes broader above, so as to hold the brain away (Fig. 3). It is a highly-polished instrument, so that it acts also as a reflector for light. The second retractor is very similar to a uterine hook, except that it is blunt at its extremity, and forms not a right, but an obtuse angle with the shaft of the instrument. This is used to raise the dura mater just over the ganglion. These two retractors I have found to be of the greatest advantage, as they facilitate the manipulations at the base near the sinus and artery. Considering the favorable results so far obtained in the first five cases by the four different operators, a further trial to determine the value of this method of neurectomy is not demanded so far as its immediate benefit and the wound healing is concerned. In all neurectomies the value will be determined by its remote effects, and although the oldest case dates from August 8, 1891, with no recurrence of pain, more cases will be required to substantiate its value, and a longer duration of time must elapse without recurrence of pain.

The following plates, taken from photographs, represent exactly the various steps and the field of the operation:

This drawing (Fig. 4), which is made from a photograph taken from a cadaver upon which the method was performed, shows the incision made through the skin, muscle and periosteum. The incision through the skin and muscle is exactly shown in the drawing. I do not find it necessary to complete the omega cut, as the lower straight part of the omega incision is unnecessary. The incision through the periosteum is shown in this drawing, except at the extremities of the incision. Here the periosteal incision converges upon each extremity beneath the muscular flap for about one-half a centimeter so as to cause a cleavage in the bone when elevated. This part of the periosteal incision is made by retracting the skin and muscle flap slightly upon each side. The point at which the periosteal incisions converge is just at the level of the zygoma.

Fig. 5 shows the manner of holding the chisel in cutting the groove. This is done in one continuous motion, with the lower chisel at first, and cutting to the vitreous plate in all parts of the groove. The smaller chisel, which exactly fits in the groove of the larger one, is used to cut through the vitreous plate above. At the upper portion of the groove the larger chisel is used in cutting the vitreous for a space large enough to insert the elevator. At the extremities of the periosteal incision the smaller chisel is used with great care so as to cause an even break in the bone.

In Fig. 6 the fragment has been elevated and turned down, showing the dura mater with the middle meningeal artery and the groove in the parietal bone for the artery. The middle meningeal artery is tied here, if injured by being torn out of the groove.

In Fig. 7 the flap has been turned down, and the periosteum has been loosened below the level of cleavage in the bone. The bone thus bared has been removed with cutting forceps (about one centimeter in width) to below the level of the zygoma and nearly on a level with the floor of the fossa. The dura mater has been separated with the finger from the floor of the fossa, and the brain and dura have been raised by a retractor, exposing the nerve on the floor of the fossa.

The third, fourth, sixth and first divisions of the fifth nerve have been retracted to show the cavernous sinus. The second and third divisions are seen to the outer side, and at the posterior extremity of the sinus.

Behind the third division is seen the middle meningeal artery in the foramen spinosum. At the point of convergence of the three divisions of the fifth nerve and beneath them is the carotid artery. It is not seen in the drawing, nor was it obtained in the photograph from which the drawing was taken.

It is at this stage that the second and third divisions are cut at the foramen rotundum and ovale. The next step is to fasten these ends with forceps, and while using slight traction to divide the sheath upon the superior aspect at its attachment to the dura, forming the Cavum Meckelii. The ganglion is now loosened from the superior wall with a very small spoon and removed. The sheath of the nerve is finally divided upon its inferior aspect at the outer border of the cavernous sinus and carotid artery.

Fig. 8 is a drawing taken from a photograph upon the same cadaver to show the relation of the third, fourth, sixth, and first, second and third divisions of the fifth nerve. In this drawing the brain was removed in order to obtain the view from above.

UofM

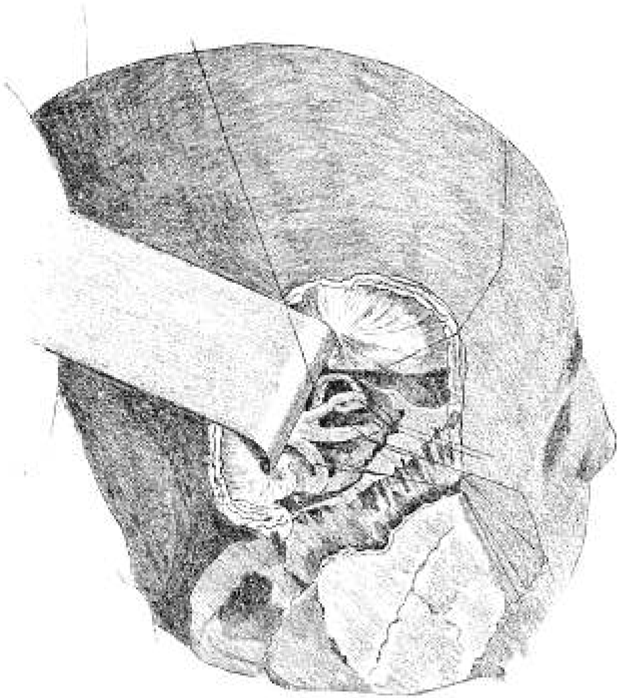

Fig. 7.—Brain and dura retracted, showing structures on the floor of the fossa.

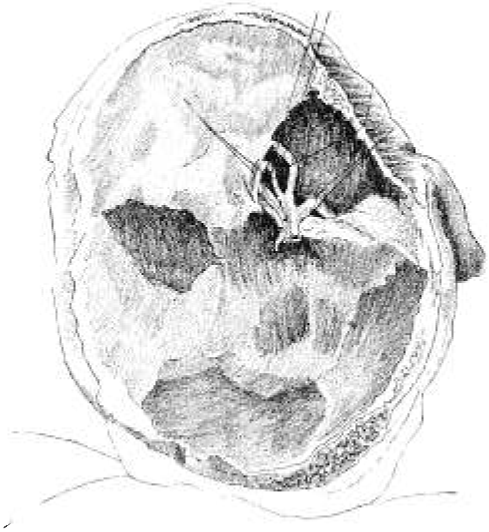

Fig. 8.—Showing the relations of the third, fourth, fifth and sixth cranial nerves.